Classical Mechanics
Phy 235, Lecture 15.

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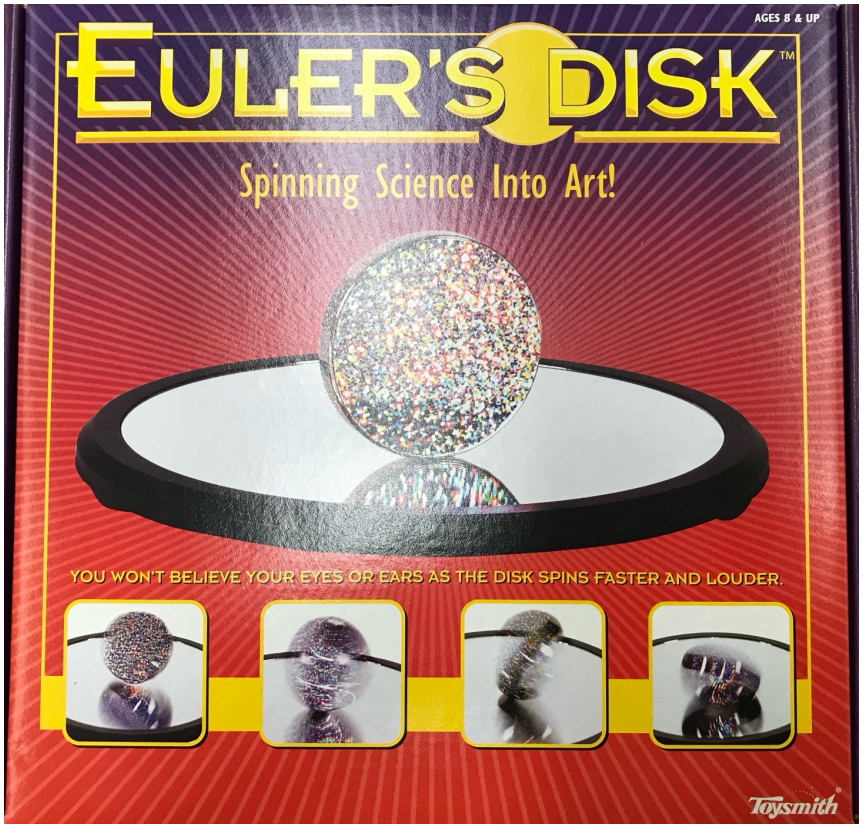
Comments on the PHY 235W Paper.

- Develop a strict schedule.
- For example:
  - First draft ready by Monday November 10.
  - Discuss with writing fellows during the week of November 10. **Schedule a meeting now!**
  - Modify paper during the week of November 17.
- Past mistakes:
  - Asking for an extension.
  - Unable to meet with writing fellows.
  - Too many topics (little depth).
  - Plagiarism.
- Paper due on 11/26/2025.



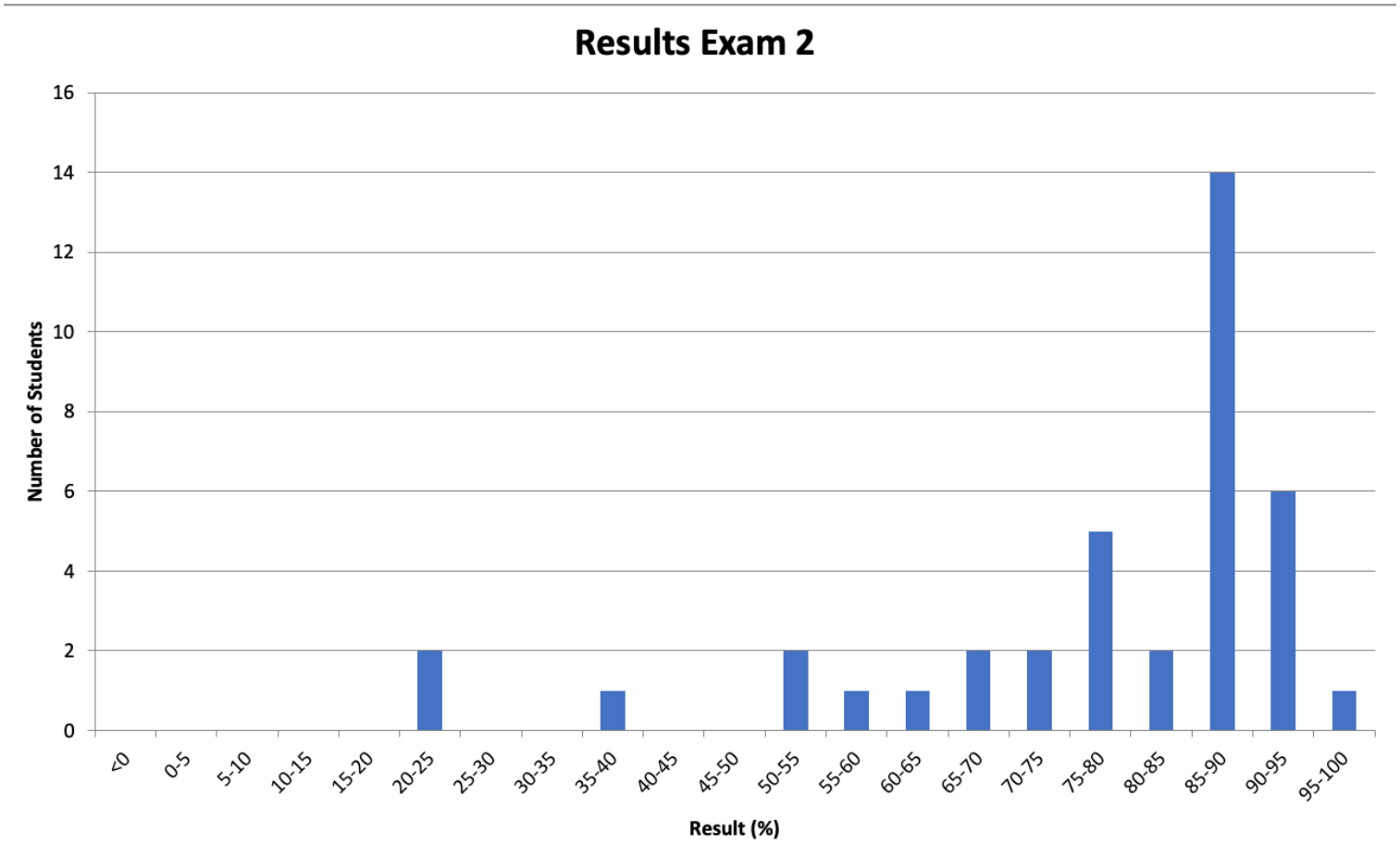
Topics were due on 10/24/2025.

So where are my KLM photos?

Comments on Exam 2

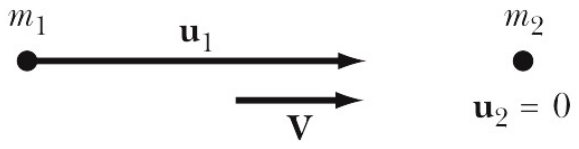
- Problem 1:
  - Similar, but simpler than Example problem 5.1.
  - Average score: 17.5/25
- Problem 2:
  - Homework problem (HW # 5, Problem # 2)
  - Average score: 21.6/25
- Problem 3:
  - Example problem 7.10.
  - Average score: 18.7/25
- Problem 4:
  - The KLM is 106 years old.
  - Average score: 17.9/25

Results Exam 2



Collisions.
Laboratory and Center-of-Mass Frames.

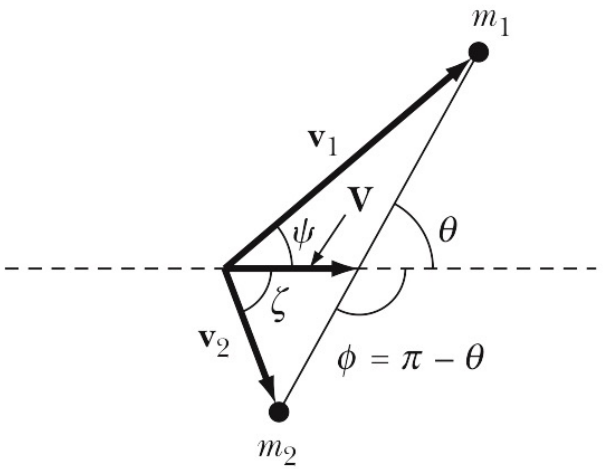
Laboratory System



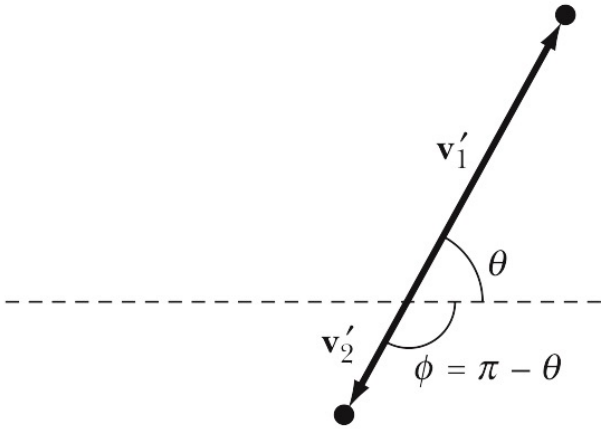
(a) Initial condition

Center-of-Mass System

(b) Initial condition

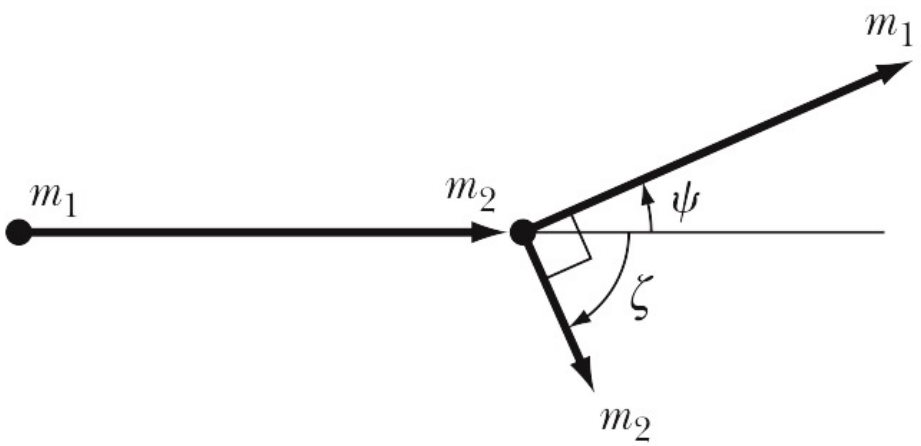


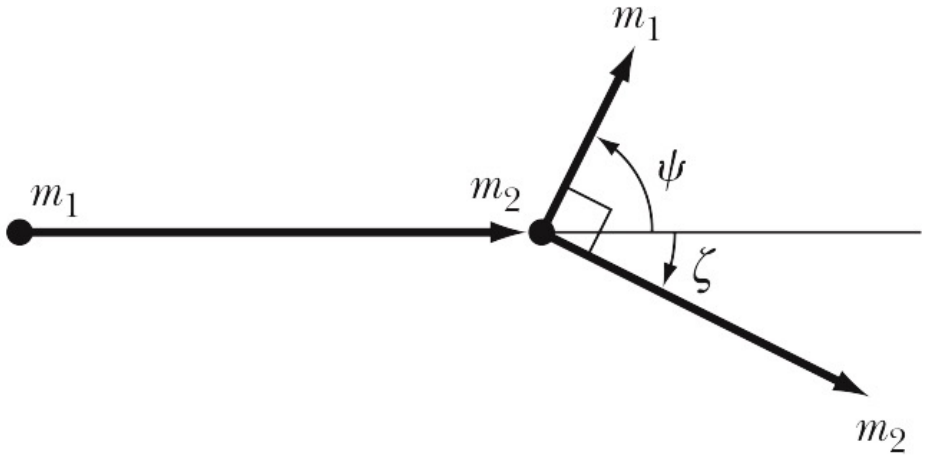
(c) Final condition



(d) Final condition

Outcome of collisions not uniquely defined.





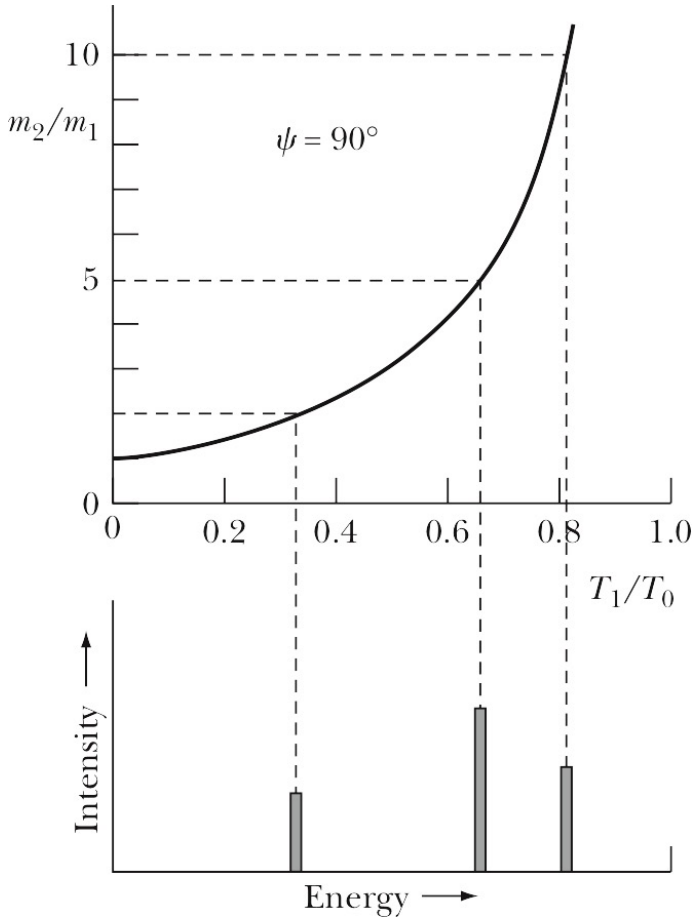
If the mass of particle 1 is equal to the mass of particle 2, the two masses will always move at right angles with respect to each other after the scattering.

Using elastic collisions to probe targets.

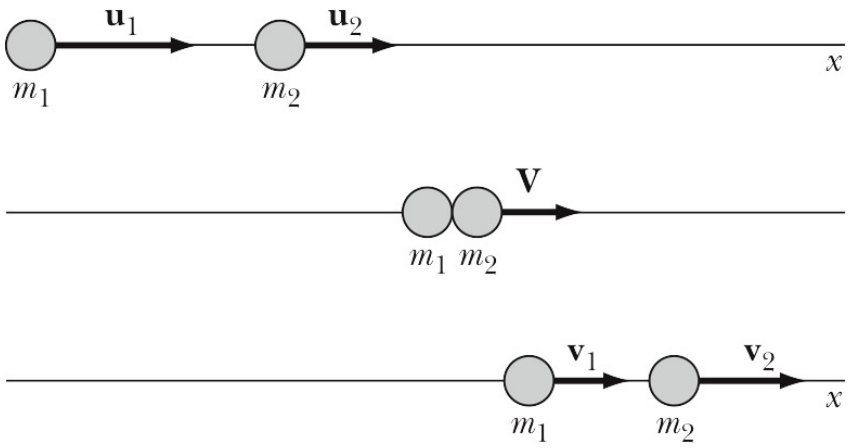
Collisions can be used to probe targets.

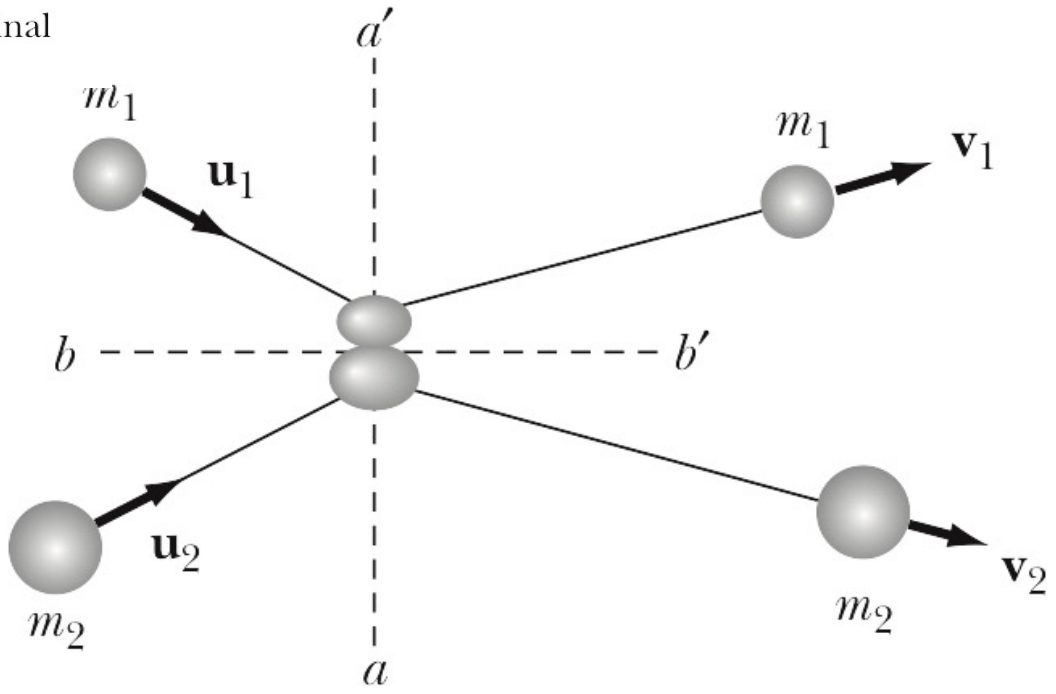
$$T_{final} = \frac{m_1^2}{m_1^2 + m_2^2}\left[\left(\frac{m_2}{m_1}\right)^2 - 1\right] T_{initial}$$

If you know the projectile mass/kinetic energy and you measure its final kinetic energy, you can determine the mass of the target.



1D and 2D Collisions.



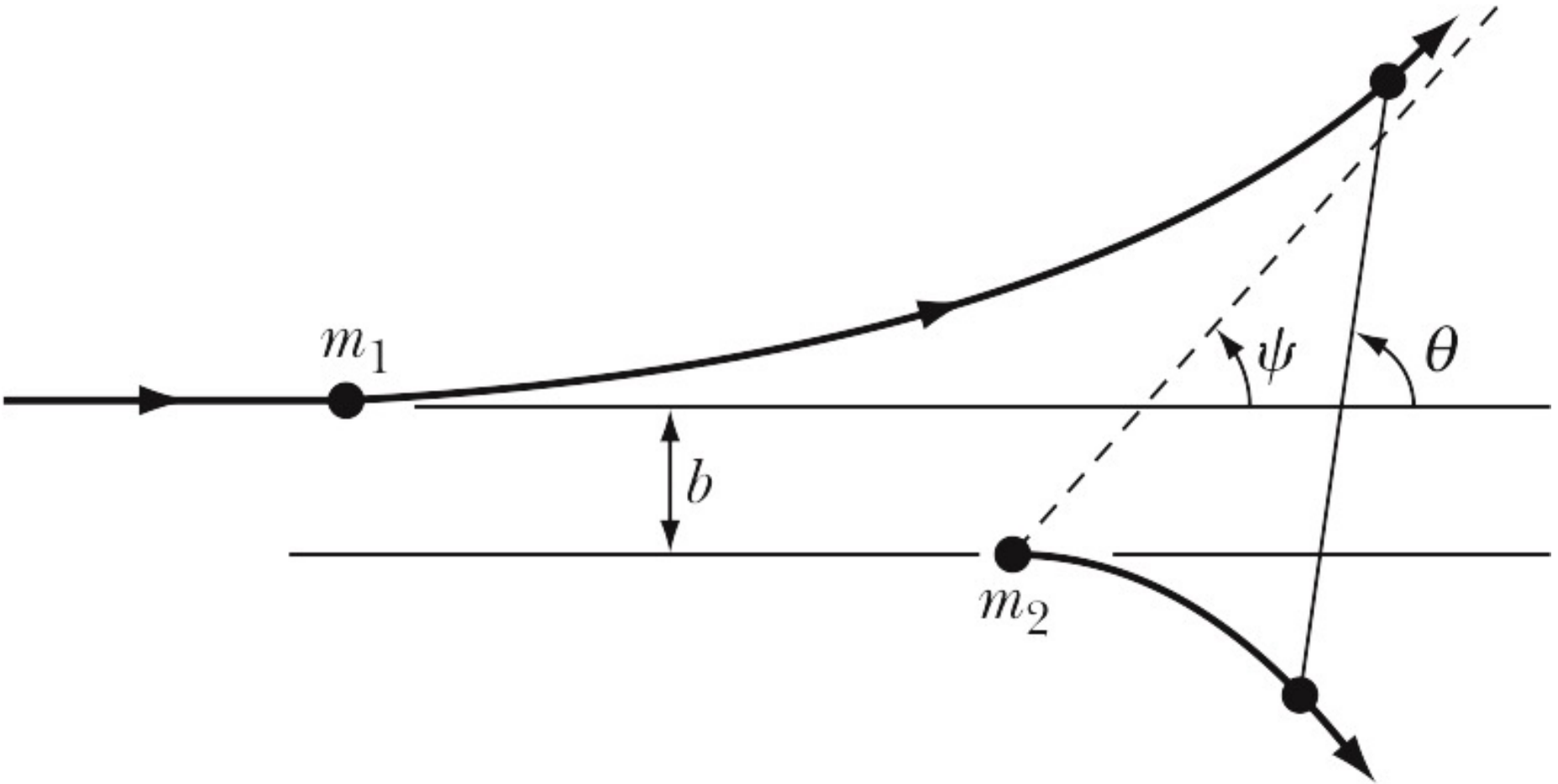


2 Minute 37 Second Intermission.

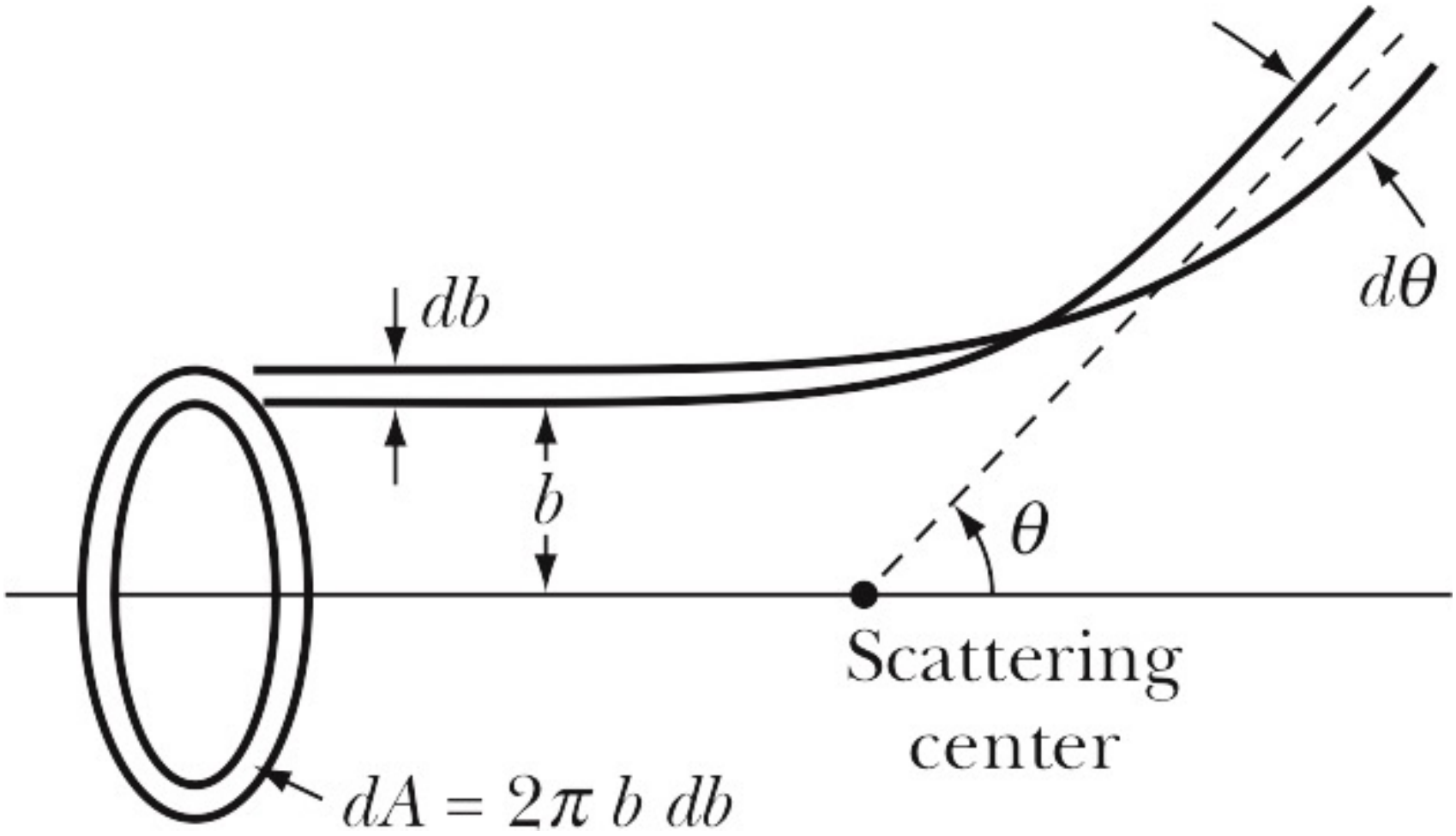
- Since paying attention for 1 hour and 15 minutes is hard when the topic is physics, let's take a 2 minute 37 second intermission.

- You can:
  - Stretch out.
  - Talk to your neighbors.
  - Ask me a quick question.
  - Enjoy the fantastic music.

Impact parameter and scattering angle.

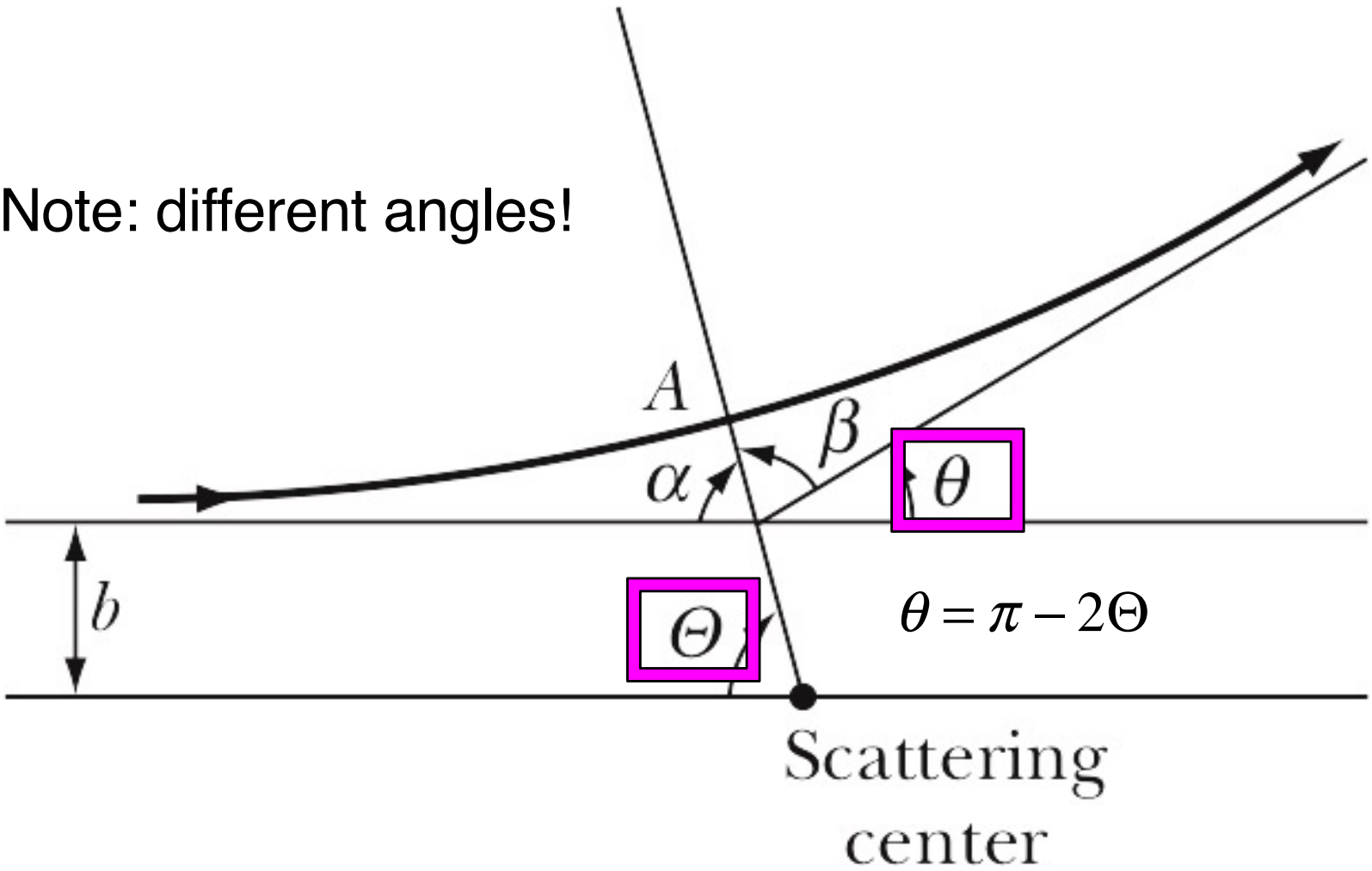


Impact parameter and scattering angle.

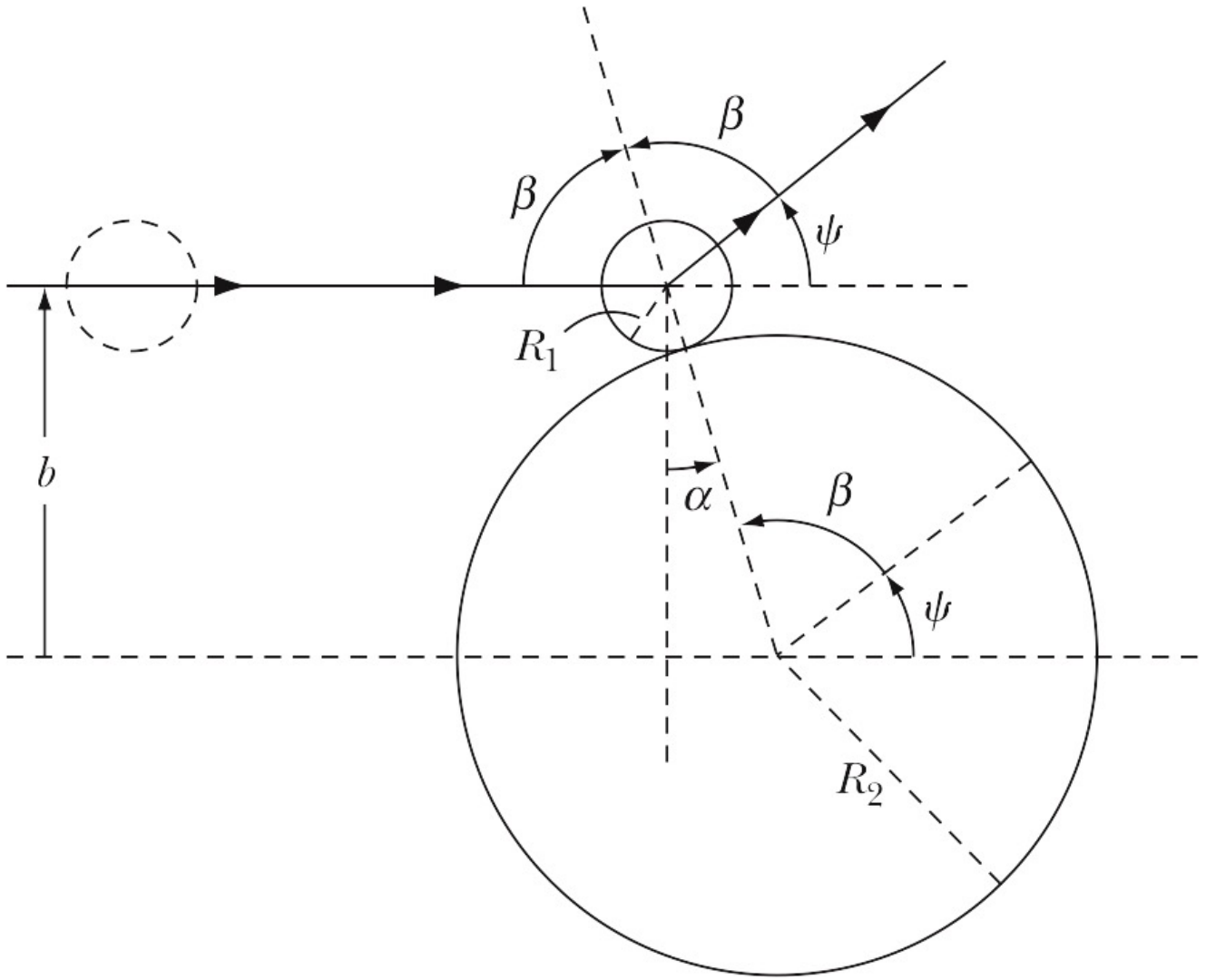


Connecting impact parameter and scattering angle: Coulomb repulsion.

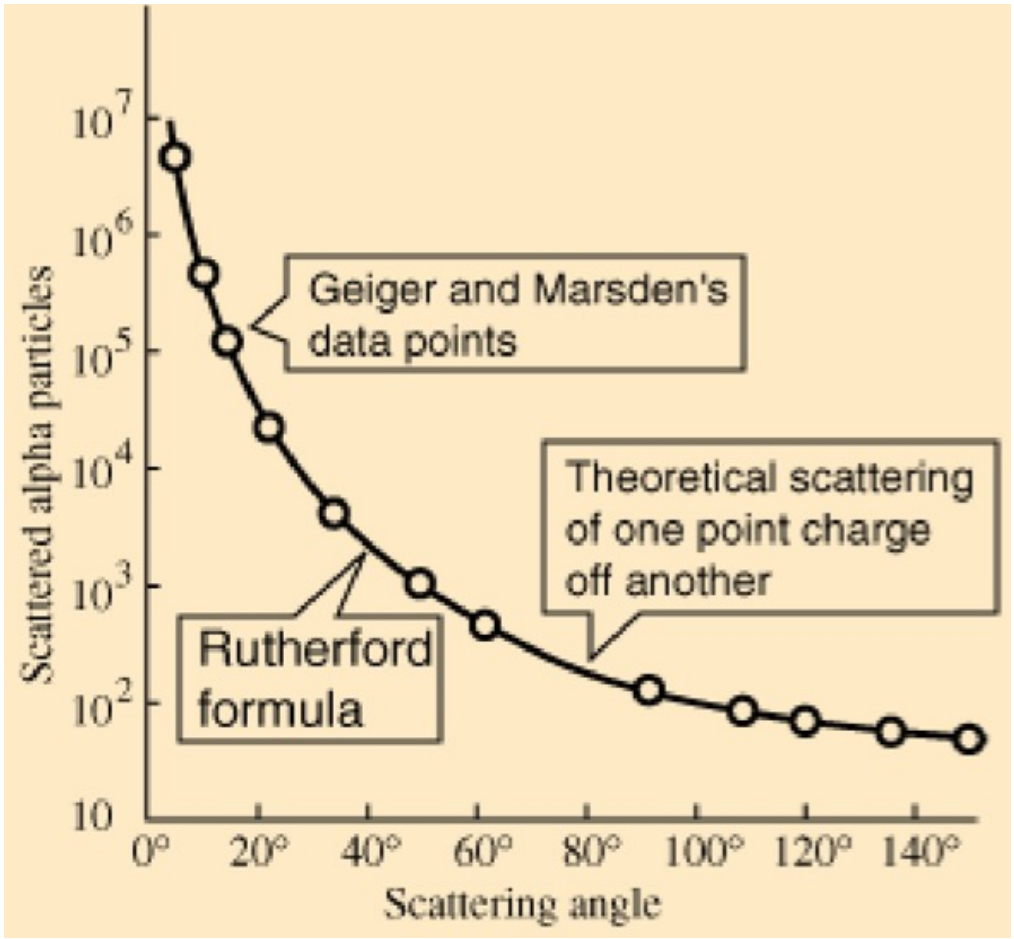
Note: different angles!

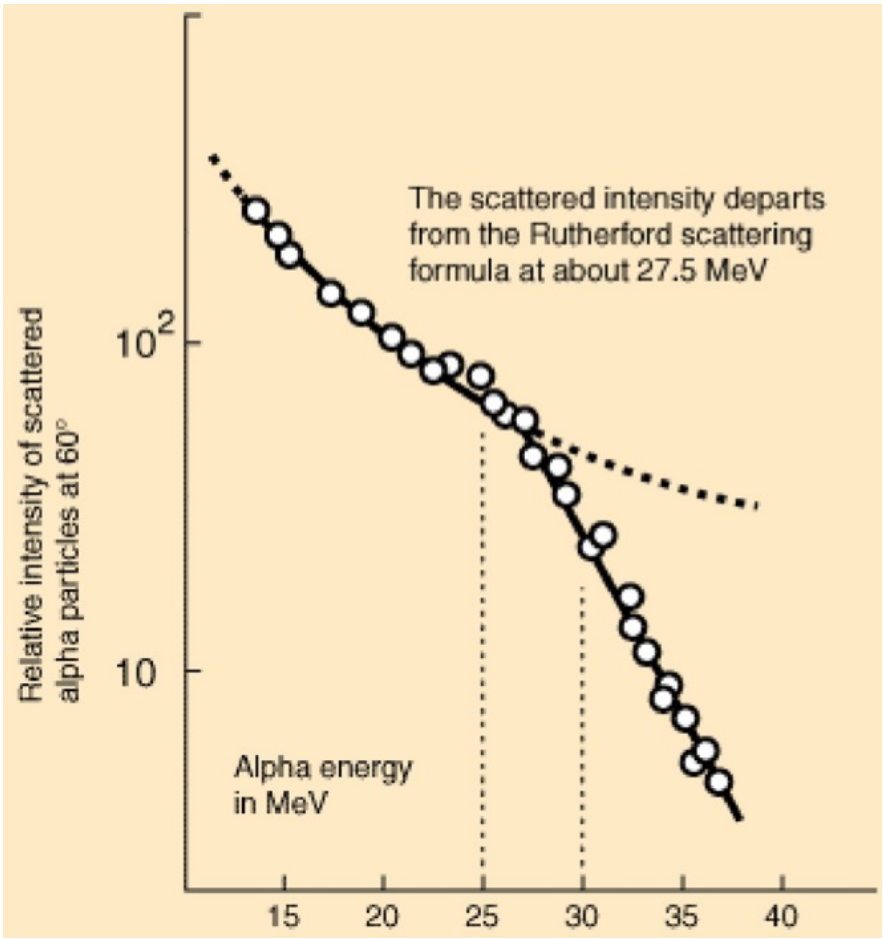


Connecting impact parameter and scattering angle: “hard” scattering.



Rutherford Scattering





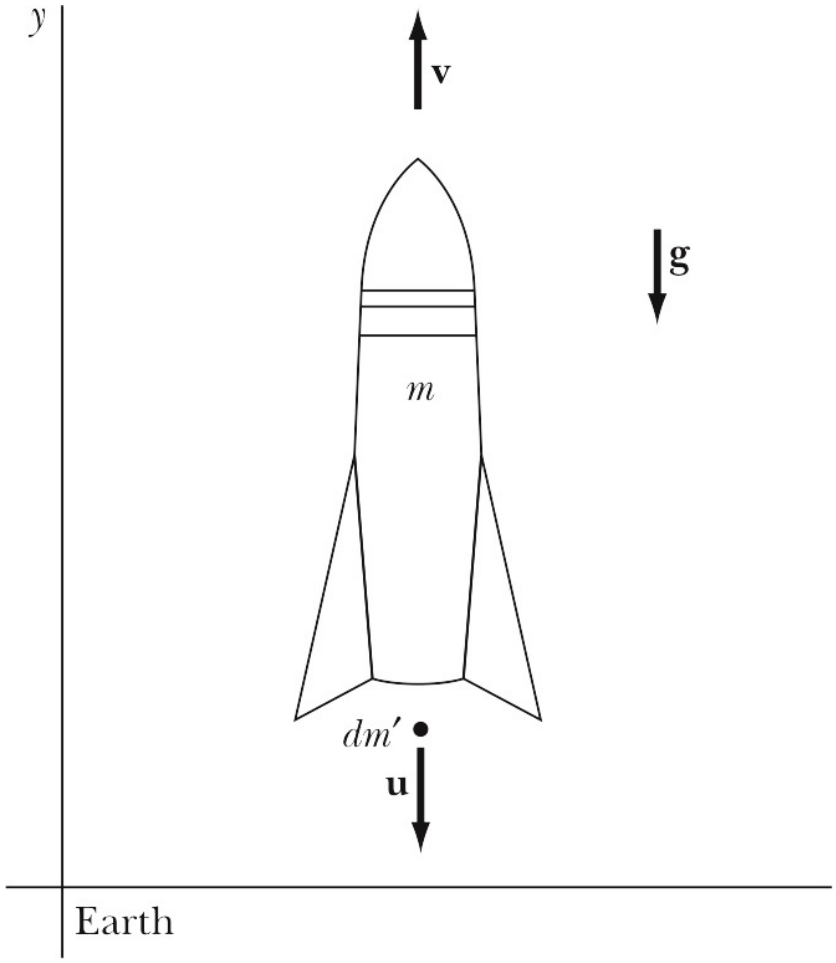
Rocket motion.

- Good example of a variable mass system.
- **First rocket equation**:

$$Ru = Ma$$

  - $R = dM/dt$ is the rate of fuel consumption.
  - u is the positive velocity of the exhaust gasses relative to the rocket.
  - a is the acceleration of the rocket.
- **Second rocket equation**:

$$v_f = v_i + u \ln\left(\frac{M_i}{M_f}\right)$$



ENOUGH FOR TODAY?